ISSN (print) 0093-4666 © 2011. Mycotaxon, Ltd. ISSN (online) 2154-8889

MYCOTAXON

Volume 115, pp. 83–98 *January–March 2011*

DOI: 10.5248/115.83

New or noteworthy records of *Caloplaca* (*Teloschistaceae*) from Poland

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Abstract— *Caloplaca atroalba*, *C. dichroa*, *C. marmorata*, *C. oasis,* and *C. pseudofulgensia* are reported as new to Poland. Two other taxa: *C. albopruinosa* and *C. pusilla* are discussed in view of modern approaches. The species reported here were mainly collected in the Polish Carpathians. Additionally, *C. atroalba* is reported as new to Ukraine. Detailed taxonomic descriptions and comments are provided for the treated taxa.

Key words— Central Europe, geographical distribution, lichenized fungi, taxonomy

Introduction

According to the checklist of the Polish lichen biota (Fałtynowicz 2003) and the most recent publications (Bielczyk 2003, Ceynowa-Giełdon & Adamska 2005, Wilk & Flakus 2006, Śliwa & Wilk 2008), 67 species of *Caloplaca* are known from Poland. The genus is relatively well-known in Poland, as it is in neighboring countries (Germany, Czech Republic, Slovakia, Ukraine). Among the authors that mostly contributed to this knowledge in Poland, Tobolewski (1956, 1958), Glanc & Tobolewski (1960), Nowak (1960, 1961), Nowak & Tobolewski (1975), and Alstrup & Olech (1988, 1992) are the best representatives.

The author has already reported on her 2004–2008 study of the taxonomic diversity of calcicolous *Caloplaca* species in the Polish Western Carpathians (Wilk 2008). In the course of this survey, several species were recognised as new to Poland. Some of them were reported recently (i.e., Wilk & Flakus 2006, Śliwa & Wilk 2008), and the remainder is presented here: *C. atroalba*, *C. dichroa*, *C. marmorata*, *C. oasis*, and *C. pseudofulgensia*. In addition, several noteworthy species were found in the area; two of them (*C. albopruinosa* and *C. pusilla*) are discussed in detail also in this study. Recently, the taxonomic placement

of the latter two species has been changed and they are presented here in their modern sense.

Material & methods

Specimens collected by the author and further material obtained from KRAM, KTC, UGDA, and herbaria of the Gorce National Park (GPN) and the Pieniny National Park (PPN) were examined. Additional reference material was studied in the Minnesota herbarium (MIN).

Morphological characters were measured on dry material using a dissecting microscope. Thallus color was compared with the color standard by Séguy (1936). Anatomical characters were measured from hand-cut sections and squash preparations mounted in water. The structure of paraphyses and cortical tissues were observed in 25% KOH (K). The granulation of tissues was observed in polarized light; pol+/ pol– indicates that granules do/do not reflect polarized light. Solubility of granules and/or crystals was tested with K and 65% nitric acid (N). Chemicals used in spot test reactions were: K, Lugol's iodine [0.3% IKI] (I) and N. The terminology for tissues follows Bungartz (2002), Ryan et al. (2002) and Gaya (2009). Systematic nomenclature of lichen associations and species concepts follow Roux et al. (2009), and additional lichen association data are provided by Gaya (2009).

Taxonomy

Caloplaca albopruinosa (Arnold) H. Olivier, Mém. Soc. Sci. Nat. Math. Cherbourg 37: 147 (1909).

Thallus endolithic or partially epilithic, thin, continuous to slightly cracked, white or grey (Séguy 1936, color code: 494), rarely limited by a dark grey prothallus; without vegetative propagules. Apothecia zeorine, abundant, in groups or more rarely slightly scattered, ±immersed at first, becoming sessile, round or slightly angular by mutual compression or flexuose, 0.2–1.2 mm diam., leaving pits in the rock when detached; disc at first slightly concave, then flat, black (Séguy 1936, color codes: 527, 528), more or less white or bluish due to pruina; proper margin persistent, thick, smooth (margin sometimes discontinuous and slightly cracked in young apothecia), distinctly raised above the disc, black, white or bluish due to pruina; thalline margin inconspicuous or suppressed. Parathecium well developed, thick, 65–170 μm, prosoplectenchymatous, lumina of cells elongated or slightly oval, outer part blackish. Amphithecium much reduced with few algae, cortex sometimes well developed up to 50 μm, paraplectenchymatous, cells with big round lumina, almost completely filled by small, yellow brown crystals (pol+, insoluble in K, soluble in N). Epihymenium granular, grey. Hymenium hyaline, without crystals, 80–115 μm tall. Paraphyses simple, constricted at septa, 1–2(–3) apical cells slightly thickened, up to 5 μm wide. Hypothecium hyaline, with many

oil droplets, paraplectenchymatous. Asci 8-spored, spores polaribilocular, thin-walled, 12–16.5 × 6.5–10 μm, isthmus 2–4(–5) μm wide. Pycnidia rather common, immersed in rock or thallus; ostiolum black, distinct; conidia colorless, ellipsoid to ovoid, 2–3.5 × 1–1.5 μm.

Spot test reactions: thallus K–, epihymenium K+ violet, KN+ violet-brown and outer part of parathecium K+ violet.

Distribution and ecology — *Caloplaca albopruinosa* has a Central Europe–Mediterranean distribution (Nimis et al. 1987). It grows on limestone and dolomite rocks in sun-exposed places in the subalpine and alpine belts (e.g., Alps, Apennines) and occasionally at lower elevations (Nimis 1993, Nimis et al. 1996a, Muggia et al. 2008). The species is characteristic of the association *Bagliettoetum marmoreae* Roux 1978.

In Poland *C. albopruinosa* is rare, occurring in the Carpathians only in Tatra Mts. Eitner (1901) also reported the species from the Sudety Mts. It grows on limestone boulders in sun-exposed situations ca. 1200 m in montane glades.

Exsiccates seen — Arnold, Lich. Exsicc. 1222 (sub *Pyrenodesmia agardhiana*) (KRAM).

Specimens examined — **Poland. Western Carpathians,** West Tatra Mts: Dolina Chochołowska valley, Polana Dudowa glade, alt. 1185 m, 49°14'58"N/19°49'37"E, 16 Jul 2004, *L. Śliwa 3151, 3169, K. Wilk 2157* (KRAM), Dolina Kościeliska valley, Przysłop Miętusi glade, 49°15'48"N/19°53'22"E, 15 Jul 2004, *L. Śliwa 3026* (KRAM).

Comments — *Caloplaca albopruinosa* is characterized by an endolithic thallus and black, white pruinose apothecia with thick proper margin. The amphithecium is reduced with few algae. The epihymenium is grey and reacts K+ violet.

Together with *C. alociza* (A. Massal.) Mig., *C. badioreagens* Tretiach & Muggia and *C. erodens* Tretiach et al., *C. albopruinosa* forms a group of species characterized by black apothecia and an endolithic thallus. *Caloplaca albopruinosa* (= *C. agardhiana* auct., see Muggia et al. 2008 for nomenclature) is a problematic species, considered by some authors as a synonym to *C. alociza*. The presence or absence of crystals in the hymenium was a primary key character used to distinguish both species (Clauzade & Roux 1985, Nimis 1992), but recent studies indicate that crystals may occur in *C. albopruinosa* as well as in *C. alociza* (Muggia et al. 2008). Current concepts separate *C. alociza* from *C. albopruinosa* by a thin evanescent apothecial margin and by more rarely white pruinose apothecia. A brownish grey epihymenium (K+ brownish red) and paraphyses neither apically thickened and nor constricted at the septa distinguish *C. badioreagens* from *C. albopruinosa* (Tretiach & Muggia 2006). In comparison to *C. albopruinosa*, *C. erodens* has smaller apothecia with distinct thin proper margins and an endolithic-epilithic thallus producing grey soredia. This species occurs mostly as a sterile form (Tretiach et al. 2003).

Caloplaca atroalba (Tuck.) Zahlbr., Cat. Lich. Univ. 7: 68 (1930). PLATE 1

THALLUS epilithic, thin, areolate or continuous, brownish grey or creamy brownish (Séguy 1936, color codes: 234, 235, 338, 339), epruinose, rarely limited by a grey prothallus; without vegetative propagules. Areoles irregular, flat, with uneven surface. Thallus cortex paraplectenchymatous, without crystals; algal layer continuous; medulla prosoplectenchymatous. APOTHECIA zeorine, abundant, in the centre of the thallus, crowded, sessile from the beginning, round or angular by mutual compression, small, up to 0.5 mm diam.; disc flat, dark brown (Séguy 1936, color code: 117), epruinose; proper margin persistent, thin, concolorous with disc, epruinose; thalline margin usually persistent or ±reduced, but visible at least at the base of apothecia. Parathecium well developed, 50–65 µm thick, paraplectenchymatous, lumina of cells oval or round, outer part brown and without crystals. Amphithecium present, algae abundant, cortex poorly developed. Epihymenium brownish grey or pale brown. Hymenium hyaline, sometimes with fine crystals (pol–, insoluble in K), 85–115 µm tall. Paraphyses simple or slightly branched, constricted at septa, 1–3 apical cells slightly thickened, up to 5 µm wide, or apical cells not thickened. Hypothecium hyaline, sometimes with fine crystals (pol–, insoluble in K). Asci 8-spored, spores polaribilocular or occasionally 1-locular, thin-walled, 11.5–15 × 6–9.5 µm, isthmus ca. 1.7 µm wide, often incomplete or poorly formed. PYCNIDIA inconspicuous, immersed in thallus; conidia not observed.

SPOT TEST REACTIONS: thallus K+ violet, epihymenium and outer part of parathecium K+ violet.

DISTRIBUTION AND ECOLOGY — *Caloplaca atroalba* is widely distributed in the temperate zone of North America (Wetmore 1994, 2007) and is reported from Austria (Hafellner & Türk 2001) and Sweden (Santesson et al. 2004) in Europe. It grows on calcareous and occasionally non-calcareous rocks such as limestone, dolomite, or sandstone (data from MIN herbarium labels, Johnsen 1965, Wetmore 1994, Hafellner 2001).

In the Carpathians (Pieniny and Tatra Mts) and Góry Świętokrzyskie Mts, the species grows on limestone and calcareous sandstones in sun-exposed sites up to 1100 m. This is the first report of the species from Poland and Ukraine.

SPECIMENS EXAMINED — **POLAND. Western Carpathians,** Pieniny Mts, limestone outcrops by Czorsztyn Castle, alt. ca. 600 m, 49°26'11"N/20°18'48"E, 5 Jun 2005, *K. Wilk 3470b* (KRAM); West Tatra Mts, Dolina Chochołowska valley, Polana Chochołowska glade, alt. 1105 m, 49°14'16"N/19°47'47"E, 16 Jul 2004, *L. Śliwa 3118* (KRAM). **Góry Świętokrzyskie Mts,** Kielce County: Wesoła town above Wierna Rzeka river, hill near railway, 31 Aug 1976, *K. Toborowicz* (KTC-6332).

ADDITIONAL MATERIAL EXAMINED — **UKRAINE. Khmelnitskyi region,** Kamianets Podilskyi district, National Park "Podilskyi Tovtry": Kitaihorod, 15 km SE of Kamianets Podilskyi, 48°38'25"N/26°46'58"E, 24 Jun 2003, *P. Czarnota 3793* (KRAM), Bagota on the Dniester near Stara Ushytsia, 30 km SE Kamianets Podilskyi, alt. 259 m, 48°35'10"N/26°59'57"E, 25 Jun 2003, *J. Kiszka* (KRAM-L 63304).

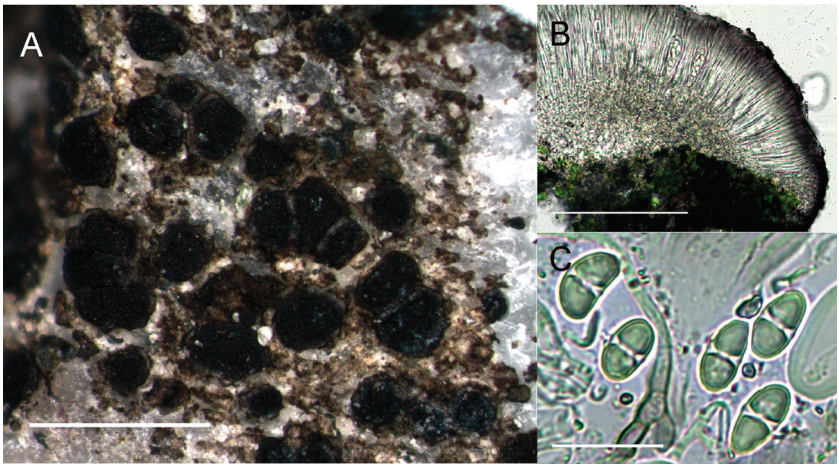

Plate 1. *Caloplaca atroalba* (*L. Śliwa 3118*, KRAM): A – habit; scale bar= 1 mm. B – vertical section of apothecium; scale bar= 150 µm. C – ascospores; scale bar= 20 µm.

Comments — *Caloplaca atroalba* is characterized by a creamy brown, epruinose, areolate thallus. The brown, epruinose apothecia usually have a persistent thalline margin. Spores have a thin isthmus (ca. 1.7 µm diam) and are often poorly formed. The epihymenium is brown and K+ violet.

Caloplaca atroalba can be similar to *C. albovariegata* (B. de Lesd.) Wetmore, *C. chalybaea* (Fr.) Müll. Arg., *C. diphyodes* (Nyl.) Jatta, *C. pratensis* Wetmore, and *C. variabilis* (Pers.) Müll. Arg. According to Wetmore (1994), *C. atroalba* is more common in Europe than currently thought but has been often misidentified as *C. diphyodes*. The latter, however, differs by producing spores with a wider isthmus (> 3 µm diam.) and a shorter (usually ≤ 100 µm) hymenium. An additional distinguishing feature is the parathecial structure, which is prosoplectenchymatous in *C. diphyodes* (Wunder 1974, Oksner 1993, Kondratyuk et al. 2004).

Caloplaca albovariegata can be distinguished from *C. atroalba* by its distinct grey areolate thallus with areoles constricted at the base. Moreover, *C. albovariegata* has a discontinuous algal layer (algal clusters separated from one another by vertical columns of hyphae) and a necral layer over the cortex. The species is known only from North America, but Wetmore (1994) notes that it probably also occurs in Europe.

Caloplaca atroalba may also be confused with *C. chalybaea* and *C. variabilis,* even though in the two latter species thalli and apothecia are covered by conspicuous white pruina (hyaline crystals visible in section, pol+, insoluble in K) and produce spores with considerably wider isthmuses. Moreover, the apothecia of *C. chalybaea* are ± immersed in the thallus and have a hypothecium

that consists of distinct rows of small isodiametric cells (Wetmore 1994). Finally, Wetmore (2009) recognises *C. atroalba* as a non-sorediate counterpart of *C. pratensis,* recently described from North America.

Caloplaca dichroa Arup, Lichenologist 38: 13 (2006).

Thallus epilithic, 0.1–0.4 mm thick, granular-areolate, sometimes with small indistinct lobes at margin, yellow, yellowish orange or dark orange (Séguy 1936, color codes: 256, 257, 201), often occurring with yellow and orange thalli side by side, prothallus seldom present, concolorous with thallus. Areoles continuous to scattered, irregular, flat to convex, often with slightly incised margins; blastidia and granules numerous on the surface and margin of areoles, usually covering most of the thallus, 30–90 µm diam. Thallus cortex very thin, up to 10 µm; medulla with many yellow crystals. Apothecia zeorine, present or absent, not abundant, scattered in the centre and near margins of the thallus, slightly immersed at first, then sessile, round or flexuose when old, 0.5–1.5 mm diam.; disc flat, somewhat convex in old apothecia, orange (Séguy 1936, color codes: 211, 246); proper margin concolorous with disc or slightly paler, smooth; thalline margin thick and prominent at first, becoming reduced and visible at the base of apothecia, smooth or crenulate, or alternatively ±persistent and only slightly reduced. Parathecium thin or thick, prosoplectenchymatous, lumina of cells oval or round. Amphithecium often reduced and visible only at the base of apothecium, algae abundant and in groups. Epihymenium granular, brownish yellow. Hymenium hyaline, 65–95 µm tall. Paraphyses simple, slightly branched or anastomosing, with oil droplets, 1–3(–5) apical cells thickened, up to 5–8 µm wide, or apical cells not thickened. Hypothecium hyaline, with oil droplets, prosoplectenchymatous. Asci 8-spored, spores polaribilocular, thick-walled (1–2 µm wide), 10–15 × 5–8 µm, isthmus 2.0–4.5 µm wide. Pycnidia common, numerous, immersed; ostiolum orange; conidia colorless, bacilliform 2–3(–4) × 1 µm.

Spot test reactions: thallus K+ purple, medulla K–, epihymenium K+ purple.

Distribution and ecology — *Caloplaca dichroa* is widespread in Europe (Arup 2006, Vondrák et al. 2009), where it grows on calcareous substrata such as limestone rocks, boulders, pebbles, and (rarely) concrete and mortar (Arup 2006). It prefers sun-exposed sites, occurs at varying altitudes (Arup 2006, Vondrák et al. 2007), and is typically inland, away from maritime influences (Vondrák et al. 2009).

The species seems to be common in the Carpathian (Pieniny, Tatra, Beskid Mały) mountain ranges on limestone and calcareous sandstones mainly in sun-exposed sites, usually on south-facing vertical rock walls or upper rocky outcrops at 500–1800 m. This is the first report of the species from Poland.

Specimens examined — **Poland. Western Carpathians,** Beskid Mały Mts, Zamczysko above Łysina village, alt. 756 m, 49°44'52"N/19°18'17"E, 22 Sept 2005, *K. Wilk 3945b* (KRAM); Pieniny Mts, Zielone Skałki rocks by Czorsztyn lake, NE of Falsztyna, alt. ca. 580 m, 49°25'56"N/20°17'35"E, 6 Jun 2005 and 12 Nov 2005, *K. Wilk 3484, 3485, 4137, 4138* (KRAM); West Tatra Mts: Wąwóz Kraków canyon, alt. 1100 m, 15 Jul 2004, *K. Wilk 2141* (KRAM), below Mnichy Chochołowskie, E of Skorusi Żleb, alt. 1300 m, 49°14'29"N/19°47'43"E, 19 Jul 2004, *K. Wilk 2177* (KRAM), Mnichy Chochołowskie, S slope, alt. 1488 m, 49°14'40"N/19°47'42"E, 19 Jul 2004, *K. Wilk 2183* (KRAM), Rzędy below Ciemniak, alt. 1800 m, 49°13'75"N/19°53'80"E, 11 Jul 2004, *K. Wilk 2109b, 2111* (KRAM).

Additional material examined — **Ukraine. Kamelnitskyi region,** Kamianets Podilskyi district, National Park "Podilskyi Tovtry", Privorita near Makiv, 10 km N of Kamianets Podilskyi, alt. 223 m, 48°47'27"N/26°38'41"E, 25 Jun 2003, *U. Bielczyk* (KRAM-L 48993).

Comments — *Caloplaca dichroa* is characterized by a yellow or dark orange granular-areolate thallus (often both color morphs occur side by side). It produces vegetative propagules, such as blastidia and granules that usually cover the thallus entirely. The distinctly thickened spore walls are diagnostic.

This species is included within the *C. citrina* group (Arup 2006). Specimens of *C. dichroa* with thin, weakly developed thalli may be difficult to distinguish from *C. citrina* (Hoffm.) Th. Fr., which is differentiated by its distinctly sorediate, yellow-colored thalli and thin-walled spores. *Caloplaca arcis* (Poelt & Vězda) Arup is distinguished from yellow-colored forms of *C. dichroa* by its thicker thallus with distinct marginal lobes and thin-walled spores. According to Vondrák et al. (2009), *C. dichroa* can also be confused with *C. austrocitrina* Vondrák et al. and *C. limonia* Nimis & Poelt, but the latter two species produce thicker thalli. Additionally, *C. limonia* produces larger vegetative diaspores and a more intensely yellow thallus.

Caloplaca calcitrapa Nav.-Ros. et al., which also produces thick-walled, sand-glass spores, is distinguished by its complete absence of vegetative diaspores (Navarro-Rosinés et al. 2000).

Caloplaca dichroa has often been confused with *C. coronata* (Kremp. ex Körb.) J. Steiner, which produces a more distinctly isidiate thallus and smaller, thin-walled spores (see Arup 2006 for comments).

Caloplaca marmorata (Bagl.) Jatta, Sylloge Lich. Ital.: 251 (1900).

Thallus endolithic, without prothallus. Apothecia pseudolecanorine, abundant, scattered or in groups, immersed in rock at first, then sessile, round or slightly angular by compression, 0.2–0.7 mm diam.; disc flat or slightly convex, more rarely strongly convex, rust to brownish orange (Séguy 1936, color code: 171, 172), epruinose; proper margin persistent, raised, particularly in young apothecia rather thick, smooth, slightly paler than disc; thalline margin not visible. Parathecium well developed, thick, 85–170 µm, prosoplectenchymatous,

lumina of cells oval. Amphithecium much reduced, algae grouped at the base of apothecium. Epihymenium granular, reddish yellow. Hymenium hyaline, 85–110 µm tall. Paraphyses simple or slightly branched, with irregular lumina, 1–4 apical cells slightly thickened, up to 5 µm wide. Hypothecium hyaline, without crystals and oil droplets, prosoplectenchymatous. Asci 8-spored, spores polaribilocular, thin-walled, 12.5–17 × 5.5–8.5 µm, isthmus 1.5–3.5 µm wide. Pycnidia not observed.

Spot test reactions: epihymenium K+ purple.

Distribution and ecology — *Caloplaca marmorata* is widespread in Europe, the Near East and north Africa (Navarro-Rosinés & Hladun 1996) and is also reported from North America (Wetmore 2007). It is a pioneer taxon occupying hard calcareous pebbles and rocks, e.g. pure limestone, marble, gypsum or sandstones (Nimis & Poelt 1987, Nimis et al. 1996b, Navarro-Rosinés & Hladun 1996). It grows in sun-exposed and dry microhabitats at varying altitudes (Nimis 1993, Navarro-Rosinés & Hladun 1996). The species is characteristic of the association *Caloplacetum lacteae-marmoratae* Roux 2009.

In the Carpathians, the species was found only in Pieniny Mts, where it grows on sun-exposed limestone sites at 500–1000 m. This is the first report from Poland.

Specimens examined — **Poland. Western Carpathians,** Pieniny Mts, near summit of Trzy Korony, 4 May 1957, *J. Nowak* (KRAM-L 4401); Małe Pieniny Mts: Dolina Białej Wody valley, near Jaworki village, 8 Jun 1968, *J. Nowak* (KRAM-L 18696), near Jaworki village, Sołtysie Skałki rocks, alt. 580 m, 49°24'20"N/20°32'30"E, 3 Jun 2005, *K. Wilk 3395* (KRAM), Jaworki village, 1888, *W. Boberski* (KRAM-L 20914).

Additional material examined — **Ukraine. Kamelnitskyi region,** Kamianets poilskyi district, National Park „Podolskyi Tovtry": Chotiri Kavalyeri near Vyerbka, 13 km N of Kamianets Podilskyi, alt. 289 m, 48°48'24"N/26°35'54"E, 25 Jun 2003, *J. Kiszka* (KRAM-L 49147), Kitaihorod, 15 km SE of Kamianets Podilskyi, alt. 141 m, 48°38'25"N/26°46'58"E, 24 Jun 2003, *M. Kukwa* (KRAM-L 48718), Tovtra Vyerbyetska Reserve, alt. 289 m, 48°48'24"N/26°35'54"E, 25 Jun 2003, *L. Śliwa 1964* (KRAM), ibid., *A. Zalewska* (KRAM–L 49328).

Comments — *Caloplaca marmorata* is characterized by an endolithic thallus and rusty or brownish orange, small apothecia with well developed proper margins. The parathecium is thick, and the amphithecium is reduced but with algae usually visible at the base of apothecium. The epihymenium is yellowish red and the spores have a thin (< 3 µm) isthmus.

The species belongs to the *C. lactea* group (Navarro-Rosinés & Hladun 1996), within which it could be confused with *C. lactea* (A. Massal.) Zahlbr., *C. lacteoides* Nav.-Ros. & Hladun, and *C. nashii* Nav.-Ros. et al. *Caloplaca lactea* has orange apothecia, persistent and thin proper margins, and broadly ellipsoid spores. *Caloplaca lacteoides* is differentiated by yellow, more rarely brownish orange apothecia, simple paraphyses with strongly thickened apical cells, an upper parathecium that is distinctly paraplectenchymatous, and very long

(≤ 25 µm) spores. *Caloplaca nashii* produces paler apothecia that are orange and never brownish or rusty, a thin parathecium, simple paraphyses with narrow or slightly thickened apical cells, and distinctly narrower spores (see also Navarro-Rosinés et al. 2001).

Caloplaca oasis (A. Massal.) Szatala, Magyar Bot. Lapok 31: 120 (1932).

Thallus strongly reduced and only some small granules or areoles visible at thallus margin, pale yellow (Séguy 1936, color code: 290), rounded in shape; without prothallus and vegetative propagules. Apothecia pseudolecanorine or zeorine, abundant, crowded, sessile, round or angular by compression, 0.1–0.3 mm diam.; disc flat or slightly convex, orange (Séguy 1936, color codes: 196, 211), epruinose; proper margin very thin, not prominent, slightly raised or level with disc, smooth, concolorous with or slightly paler than disc; thalline margin much reduced, only in young apothecia visible. Parathecium thin, ca. 60 µm, prosoplectenchymatous, hyphae radiating with oval to elongated cells. Amphithecium ±reduced, with numerous algae, cortex poorly developed. Epihymenium granular, yellow. Hymenium hyaline, 75–85 µm tall. Paraphyses simple or slightly branched above, 1–2 apical cells thickened, up to 7 µm wide. Hypothecium hyaline, without crystals or oil droplets, prosoplectenchymatous, hyphae irregular, ca. 40–50 µm high. Asci 8-spored, spores polaribilocular, thin-walled, 8.5–13.5 × (4.0–)4.8–6.8 µm, isthmus 3–5 µm wide. Pycnidia not observed.

Spot test reactions: thallus K+ purple, medulla K–, epihymenium K+ purple.

Distribution and ecology — *Caloplaca oasis,* which is widespread in Europe (Arup 2009), is also reported from Western Asia (John et al. 2004) and North Africa (Thor & Nascimbene 2010). The species grows mainly on pure limestone, concrete and mortar (Arup 2009), where it occurs as free living or a parasitic lichen growing on endolithic *Verrucaria* s. lat. The species is characteristic for the associations *Aspicilietum calcareae* Du Rietz 1925 emend. Roux 1978 and *Caloplacetum citrinae* Beschel ex Klement 1955.

The species was found in the Carpathians (Gorce Mts) at elevations up to 550 m and in the Pomeranian lowlands, where it grows on calcareous sandstones and concrete. This is the first report of the species from Poland.

Specimens examined — **Poland. Western Carpathians,** Gorce Mts, Park Dworski in Poręba Wielka, alt. 550 m, 5 Oct 1993, *P. Czarnota* (GPN 49/94). **Pomeranian Voivodeship,** Wdzydze Landscape Park: Czarlina village, near bus stop, 13 Sept 2006, *K. Wilk 7271* (UGDA), southern part of Wdzydze Tucholskie village, 53°58'05"N/17°55'32"E, 13 Sept 2006, *E. Adamska, W. Gruszka & L. Śliwa 3668a* (UGDA).

Comments — *Caloplaca oasis* is characterized by a reduced thallus and small dark orange apothecia with thin proper margins.

Arup (2009), who discusses the species in detail in the recent monograph on the *C. holocarpa* group, notes that *C. oasis* has been often misidentified as *C. holocarpa* (Ach.) A.E. Wade, especially when growing on anthropogenic substrates. However, *C. holocarpa* produces more yellow-tinged apothecia with thicker, more prominent proper margins and spores with a broader isthmus (see Arup 2009). Well-developed parasitic *C. oasis* specimens may also be confused with *C. polycarpa* (A. Massal.) Zahlbr., which can be distinguished by larger apothecia with thicker margins and more distinct, thicker orange thalli (see Arup 2009 for more details).

Caloplaca pseudofulgensia Gaya & Nav.-Ros., Biblioth. Lichenol. 101: 69 (2009).

Thallus placodioid, rosettes 2–14 mm in diam., 0.1–0.4 mm thick, single or often forming bigger congregations, yellow, creamy yellow, orange, brownish orange, sometimes pale yellow to greenish yellow in shade (Séguy 1936, color codes: 246, 226–230, 211–215), thallus in the centre often whitish, surface rough, matt, pruinose (pruina concolorous with thallus); without prothallus and vegetative propagules. Marginal lobes 0.5–2 mm long and 0.1–0.5(–0.8) mm wide, closely adjacent to each other, richly and rather irregularly branched, convex in the centre of thallus, but flat and slightly broadening at tips; surface of lobes wrinkled and with delicate furrows along. Internal areoles flat to convex, irregular or resembling small sublobules; young thallus often lacking internal areoles, and then lobes forming from the centre. Thallus cortex distinct, thin or sometimes thick, paraplectenchymatous, without necral layer, with hyaline crystals (pol+, insoluble in K, soluble in N); algal layer ±continuous; medulla dense, with numerous hyaline crystals (pol+, insoluble in K, soluble in N). Apothecia zeorine or pseudolecanorine, abundant, in centre of thallus, sessile from the beginning, crowded, rarely scattered, round or angular and flexuose by compression, 0.2–0.8(–1) mm diam.; disc flat, then convex, dark orange or brownish orange (Séguy 1936, color codes: 186, 196, 201, 202), epruinose or slightly pruinose; proper margin persistent, slightly paler than disc; thalline margin present at first, then disappearing, thick, smooth or rough, even or slightly cracked, pruinose; sometimes thalline margin excluded from the beginning and only proper margin visible. Parathecium thin or thick, 25–60 µm, prosoplectenchymatous, lumina of cells oval. Amphithecium well developed or ±reduced, algae in groups or forming a continuous layer, sometimes amphithecial tissue loose and with holes, with a paraplectenchymatous cortex, with hyaline crystals (pol+, insoluble in K, soluble in N). Epihymenium granular, brownish yellow. Hymenium hyaline, 65–90 µm tall. Paraphyses simple or seldom slightly branched, 1–2(–3) apical cells thickened, up to 6–6.5(–7.5) µm wide. Hypothecium hyaline, with numerous oil droplets, prosoplectenchymatous. Asci 8-spored, spores polaribilocular, thin-walled, 7–13 × 3–6.5 µm, isthmus 2.5–5 µm wide. Pycnidia not observed.

Spot test reactions: thallus K+ purple, J–, N–, medulla K–, J–, N–, epihymenium K+ purple.

Distribution and ecology — *Caloplaca pseudofulgensia* is widespread in Europe (Gaya 2009), where it grows on calcareous rocks in warm and sun-exposed places on north-exposed vertical walls. This nitrophilous species belongs to the association *Caloplacetum arnoldii* Clauzade & Roux 1975 (corr. Roux 2009; see also Gaya 2009).

The species was found in the Carpathian Pieniny and Tatra mountain ranges, where it is not rare. It grows on limestone in sun-exposed to shaded sites, mostly on vertical rock walls at 500–1700 m. This is the first report of the species from Poland.

Exsiccates seen — Arnold, Lich. Exsicc. 1372 (sub *Physcia pusilla*) (KRAM).

Specimens examined — **Poland. Western Carpathians,** Małe Pieniny Mts, near Jaworki village, Sołtysie Skałki rocks, alt. 580 m, 49°24'20"N/20°32'30"E, 3 Jun 2005, *K. Wilk 3415* (KRAM); West Tatra Mts: Gładkie Jaworzyńskie, 18 Aug 1925, *J. Motyka* (KRAM-L 10527), Dolina Kościeliska valley, 16 Jul 1912, *W. Augustynowicz* (KRAM-L 571), Dolina Kościeliska valley, alt. 1000 m, 25 Jul 2004, *K. Wilk 2264* (KRAM), Stoły above Dolina Kościeliska valley, S slope, alt. 1400 m, 26 Jul 2004, *K. Wilk 2277* (KRAM), Wąwóz Kraków canyon, alt. 1100 m, 15 Jul 2004, *K. Wilk 2155* (KRAM), Wąwóz Kraków canyon, slope of Saturn, alt. 1500 m, 29 May 1959, *J. Nowak* (KRAM-L 8868), Kominy Tylkowe, by trail from Przełęcz Iwaniacka pass, alt. 1700 m, 5 Jul 1955, *J. Nowak* (KRAM-L 4796), Kalacka Turnia, above Suchy Żleb, 9 Jul 1957, *J. Nowak* (KRAM-L 2472), below Mnichy Chochołowskie, E of Skorusi Żleb, alt. 1300 m, 49°14'29"N/19°47'43"E, 19 Jul 2004, *K. Wilk 2178* (KRAM), W slope of Wielka Świstówka, in the direction to Kobylaszowy Żleb, 27 Jun 2004, *A. & M. Ronikier* (KRAM-L 55074); High Tatra Mts, Kalacka Turnia, alt. 1300 m, 9 Jul 1957, *J. Nowak* (KRAM-L 122).

Additional material examined — **Slovakia. Spiš,** Ľubovňa Castle, s.d., s.coll. (KRAM-L 20803).

Comments — *Caloplaca pseudofulgensia* is characterized by a placodioid, yellow to orange thallus covered by a distinct, concolorous pruina. Marginal lobes are flat and broad at tips and the lobe surfaces are wrinkled and furrowed. Dark orange apothecia contrast with the thallus.

The species belongs to the *C. saxicola* group (Gaya 2009), of which *C. pusilla* is the most similar. However, *C. pusilla* produces robust, convex, bigger, less branched lobes with surfaces that have neither wrinkles nor furrows and a thallus that is often salmon colored and white pruinose; furthermore its apothecia, which are initially immersed in the thallus, produce bigger spores.

Caloplaca saxicola (Hoffm.) Nordin differs from *C. pseudofulgensia* in its intensely orange, epruinose, smooth thallus. The thalline lobes, which are usually short to strongly reduced, convex, ascend slightly from the rock surface. Its apothecia, which are initially immersed in the thallus before becoming sessile and aggregated, produce bigger spores.

Morphologically, *C. pseudofulgensia* can be very similar to *C. aurea* (Schaer.) Zahlbr., a species that belongs to another taxonomical group but which produces 1- or polaribilocular spores with pointed apices and a greatly reduced isthmus and considerably longer (≤ 20 µm) size. *Caloplaca aurea* also produces a thicker, epruinose thallus that does not form the rosettes typical of *C. pseudofulgensia*.

Caloplaca pusilla (A. Massal.) Zahlbr., Annal. Naturhist. Hofmuseums Wien 4: 353 (1889).

Thallus placodioid, rosettes 2–10 mm in diam., 0.3–0.4 mm thick, single or usually forming bigger congregations, yellow ochre, pinkish or salmon, often whitish in the centre (Séguy 1936, color codes: 185, 189–190, 203, 205, 215), surface white pruinose, especially in the centre of thallus, where necrosis may also occur; without prothallus and vegetative propagules. Marginal lobes 0.5–2 mm long and 0.2–0.5 mm wide, closely adjacent to each other or sometimes overlapping, convex or flat and broad at tips. Internal areoles convex, rounded to elongated, or areoles absent and lobes forming from the centre. Thallus cortex thin to thick, 13–80 µm, scleroplectenchymatous, without necral layer; layer of algae not continuous; medulla loose, with or without crystals. Apothecia zeorine or pseudolecanorine, abundant, in centre of thallus, crowded or scattered, immersed at first, then sessile and often constricted at the base, rounded or angular by compression, 0.2–1 mm diam.; disc flat or slightly convex, dark orange, brownish orange or blood-red, more rarely reddish orange (Séguy 1936, color codes: 126, 161, 168, 171, 186, 202, 247), sometimes slightly white pruinose; proper margin persistent, slightly raised or level with disc, concolorous with disc or slightly paler; thalline margin persistent or disappearing, sometimes heavily white pruinose. Parathecium thin, 30–42 µm, sclero-prosoplectenchymatous. Amphithecium with numerous algae in groups or forming a continuous layer, sometimes amphithecial hyphae loose, cortex thick, with crystals. Epihymenium granular, brown or reddish golden. Hymenium hyaline, 60–90 µm tall. Paraphyses simple or slightly branched, 1–2(–4) apical cells thickened, up to 8(–10) µm wide. Hypothecium hyaline, without oil droplets and crystals, prosoplectenchymatouseous. Asci 8-spored, spores polaribilocular, thin-walled, 8.5–15 × 4–8.5 µm, isthmus 2.5–5 µm wide. Pycnidia infrequent, inconspicuous, immersed; conidia colorless, ellipsoid to bacilliform, 3 × 1.5 µm.

Spot test reactions: thallus K+ purple, J–, N–, medulla K–, J–, N–, epihymenium K+ purple.

Distribution and ecology — The widely distributed *Caloplaca pusilla* is probably cosmopolitan (Gaya 2009). The species grows on natural calcareous rocks and mortar, is known from varying altitude and exposures, and prefers eutrophic environments. It is characteristic of the association *Caloplacetum*

pusillae Du Rietz ex Kaiser 1926 but may also be found in the *Caloplacetum arnoldii* association (see Gaya 2009).

The species, which appears widely distributed in Poland, was found in the Carpathians (Gorce and Pieniny Mts) and in the lowlands in Warmian-Masurian province. More herbaria materials need revision to determine the true distribution, because *C. pusilla* has previously been filed under the name *C. saxicola* (Fałtynowicz 2003). In Poland the species occurs on limestone, calcareous sandstones, and (commonly) concrete in sunny sites at up to 980 m.

Specimens examined — **Poland. Western Carpathians,** Gorce Mts, Boginka rock, above valley of Lubański stream, alt. 680 m, 15 Aug 1967, *K. Glanc* (KRAM-L 27476); Pieniny Mts: Popieska Skałka rock by Sronowickie lake, alt. 560 m, 49°24'48"N/20°19'50"E, 5 Jun 2005, *K. Wilk 3457* (KRAM), below summit of Trzy Korony, 4 May 1957, *J. Nowak* (KRAM-L 3786, KRAM-L 3790), Czorsztyn, s.d., s.coll. (KRAM-L 20787), Podłaźce, 10 Oct 1999, *J. Kozik* (PPN), Ociemny Wierch, 5 May 1955, *J. Nowak* (KRAM-L 3245), Zielone Skałki rocks by Czorsztyn lake, NE of Falsztyna, alt. 588 m, 49°25'56"N/20°17'35"E, Nov 2005, *K. Wilk 4131* (KRAM); Małe Pieniny Mts, Zabaniszcze, Góra Trzy Skałki Mt., alt. 740 m, Aug 1980, *K. Toborowicz* (KTC). **Warmian-Masurian province,** Giżycko County, Szymonka village, concrete bridge among meadows, 11 Jun 1974, *L. Olesiński* (KRAM-L 30631).

Comments — *Caloplaca pusilla* is characterized by a placodioid, yellow ochre, pinkish or salmon colored thallus with long and ± convex marginal lobes that are tightly attached to the substratum.

Caloplaca pusilla, which was was treated as a synonym of *C. saxicola* for many years, has been just recently recovered as independent by Gaya (2009). *Caloplaca saxicola* differs from *C. pusilla* by an epruinose thallus with short to strongly reduced lobes that ascend distinctly from the rock, apothecia that are initially immersed in thallus and form finely, bigger and strongly aggregated clusters. The spores of *C. saxicola* are longer and narrower than in *C. pusilla*. To distinguish *C. pusilla* from *C. pseudofulgensia*, see remarks under that species.

Caloplaca pusilla often grows together with *C. arnoldii* (Wedd.) Zahlbr. and *C. clauzadeana* (Gaya) Nav.-Ros. & Cl. Roux. In comparison to *C. pusilla*, *C. arnoldii* has a distinctly reddish and smaller thallus, whereas *C. clauzadeana* has strongly convex lobes with yellowish tips and much narrower ellipsoid spores. For more details see Gaya (2009).

Acknowledgements

I am grateful to E. Gaya (Durham, USA) and U. Arup (Lund, Sweden) for peer-reviewing the manuscript and providing valuable suggestions and improvements. I also thank L. Śliwa (Krakow, Poland) for revising and commenting an early version of the paper. U. Arup is acknowledged for confirming the *C. dichroa* identification. The curators of the herbaria are thanked for sending the material for study. C.M. Wetmore (St. Paul, USA) is thanked for hospitality and constructive discussions during my visit

to the Minnesota herbarium. Financial support was provided by the Ministry of Science and Higher Education, grant no. N N303 294334.

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